Space Weather Technical Forecast

Issued on Wednesday, 17 July 2024 at 13:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: High to Moderate activity, with further M-class flares expected, and a chance of X-class flares. Chance of G1 Minor Storms late day 3 or more likely day 4 (19-20 Jul) due to CME arrival

Analysis of Space Weather Activity over past 24 hours

Solar Activity: High with peak flare X1.9 at 16/1326 UTC, from AR3738 on the southwest limb. M-flares were also observed including M1.6 from AR3753 in the northwest at 16/2124 UTC, M1.9 from AR3744 in the north-centre at 16/2206 UTC and an M5.0 from AR3743 in the southwest at 17/0639 UTC. There are a total of nineteen sunspots on the disc. AR3738 is now on the west limb, and soon moving off the disc. AR3753 and AR3744 are relatively small and simple regions, with no ongoing growth, while AR3743 is a small but more complicated region, with a mixed polarity of spots, and coupled to small regions to its south. These include AR3745, AR3747 and a re-emerged AR3742. The most complex spot visible on the disc is AR3751 in the southwest, with a clear, and moderately strong delta spot, but is also a relatively small region and has remained stable.

A series of coronal mass ejections (CMEs) were observed. The first, from the X1.9 flare, is a clear miss, passing ahead of Earth. The second, was a broad asymmetric halo and also a more typical cone to the northeast, that have both been attributed to the M1.9 at 16/2206 UTC. While the halo is likely mostly shock, these are both Earth-directed, likely arriving very late on day 3 (19 Jul) or early day 4 (20 Jul). A further CME likely occurred with the M5.0 flare, however available imagery currently remains inconclusive.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE at L1, showed weak transient effects, but was generally at background. Wind speed briefly rose to 410km/s 16/2000-17/000 UTC, but otherwise was generally around 350km/s, with below, or average density. Interplanetary magnetic field (IMF), Bt, was initially moderate at 13nT, but eased from 16/1605 UTC to be Background to Moderate at 6-10nT. North-south component (Bz), was initially positive (northward), near +12 nT, but eased after 16/1605 UTC to be more variable between +9 and -7nT. Phi angle was mainly positive (away from the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 remained at background. High energy electron flux (greater than 2MeV) observed by GOES16 was at background levels. The 24-hour fluence was below Active, with 1.02e6 integrated pfu observed at 17/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: High to Moderate activity with further M-class flares likely, and a chance of X-class flares. This is due to an ongoing chance of X-flares from AR3738, which will only recede later on day 2(18 Jul), as the magnetic looping of the spot retreats further over the western limb. Further occasional M-flares are expected throughout, with a slight chance of X-class flares.

Solar Wind /Geomagnetic Activity: The CMEs from the M1.9 flare at 16/2206 UTC been assessed as Earth-directed, likely arriving late on day 3 or early day 4 (19-20 Jul). Any fast wind

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from CH54/- is most likely to remain north of Earth, but with the potential for slight enhancements day 1-3 (17-19 Jul) with a chance of brief spells of slightly elevated winds. Geomagnetic activity is expected to be mostly Quiet to Unsettled, but with a slight chance of Active and very slight chance of G1 Minor Storm intervals days 1-3 (17-19 Jul). Any CME arrival is then expected to increase activity to Active with likelihood of G1-G2 Minor to Moderate Storm intervals, most likely late on day 3 or day 4 (20 Jul).

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at background levels, but with chance of rising above the S1/Minor Storm threshold in response to any notable flares, most likely from AR3738 before receding around the limb. High energy electron flux is expected to remain at background, perhaps rising to Moderate briefly due to any fast wind connection, but likely suppressed again with any CME arrival. The associated 24 hr fluence is expected to remain below the Active level.

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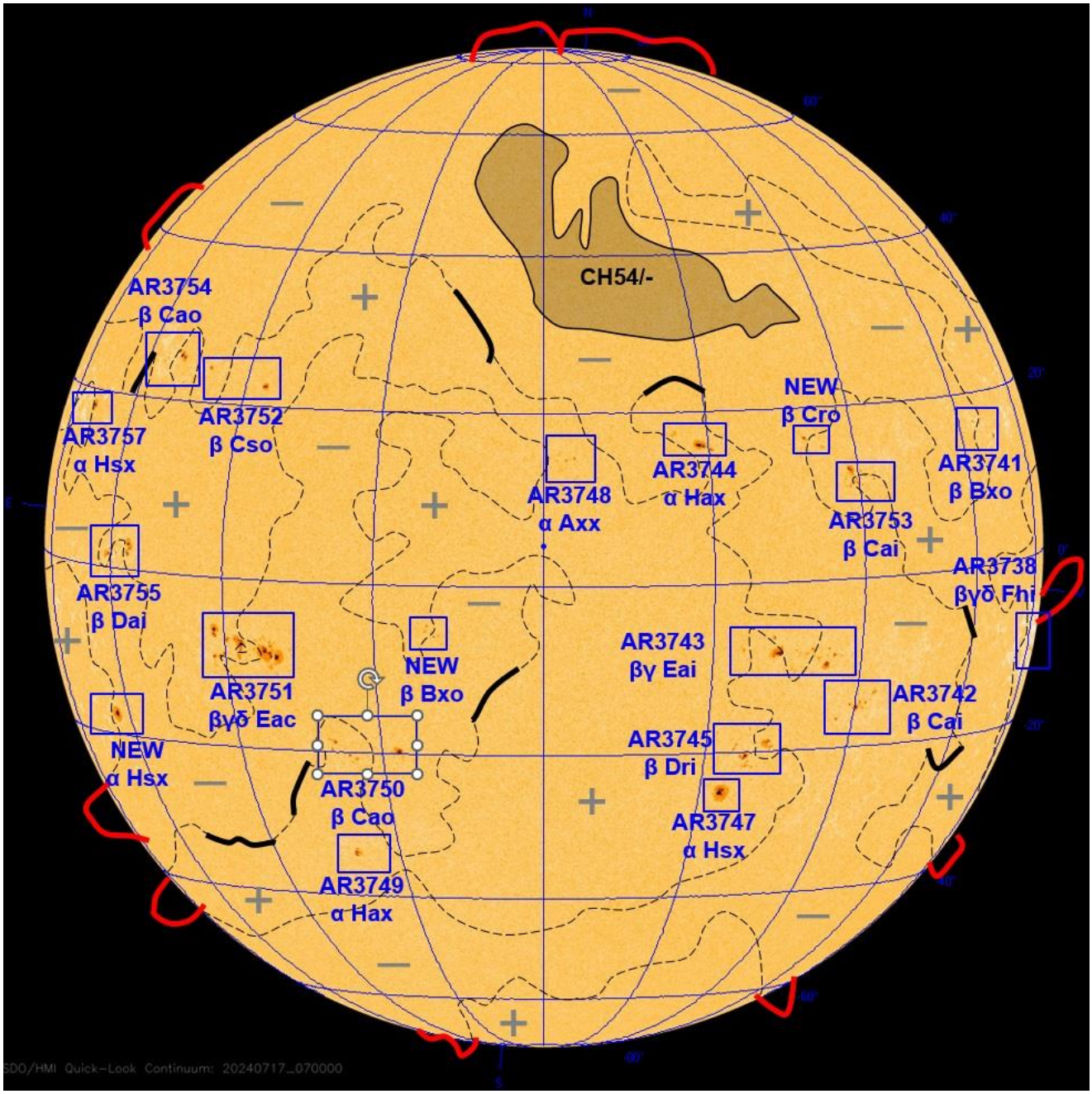
Figure 1. Solar Analysis Valid 17/0800.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

An M1.6 flare from AR3753 peaking at 16/2123 UTC in the northwest disc, was followed by an M1.9 flare from AR3744 at 16/2206 UTC. A subsequent double CME was observed, although it appears likely these were both from the second of these flares, with a main material ejecta to the northeast. This was followed with a very weak asymmetric halo CME which is possibly mostly shock, but has not been discounted for some material content. These are subsequently expected to arrive either late on day 3 (19 Jul) or more likely early day 4 (20 Jul).

This was followed by further flares, including a double peaked M5.0 flare from AR3743 at 17/0639 UTC and AR3753 at 17/0707 UTC. Available imagery is currently inconclusive for any CME release, however two weak Type II radio bursts were observed, suggestive of a CME release, and given the location of these regions, these are likely to be Earth-directed.

The fast wind from CH54/- is also something of an unknown as, although the CH was present on the last rotation, there was no obvious increase in wind speed from it. The coronal hole is likely too far north to interact with Earth, though due to its size, clarity and persistence, a slight chance of a solar wind enhancement is also catered during days 1-3 (17-19 Jul). MOSWOC Enlil is currently poor, over-estimating the enhancement.

Geomagnetic activity is expected to be mostly Quiet to Unsettled, but with a slight chance of Active to G1 Minor Storm intervals days 1-3 (17-19 Jul) should any fast wind enhancement from CH54/- be observed. Any CME arrival is then expected to increase activity to Active with likelihood of G1-G2 Minor to Moderate Storm intervals, most likely on day 4 (20 Jul).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	20	60
Strong	G3	No	1	1	1	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
17/0334	Nil	M1.9 AR3744	N-centre	691 km/s	19/2200 -6/+12 hrs	Likely combine with below CME.
17/0400	Asymmetric Halo	M1.9 AR3744	N-centre	530 km/s	19/2200 -6/+12 hrs.	Possibly mainly shock, but will combine with above.

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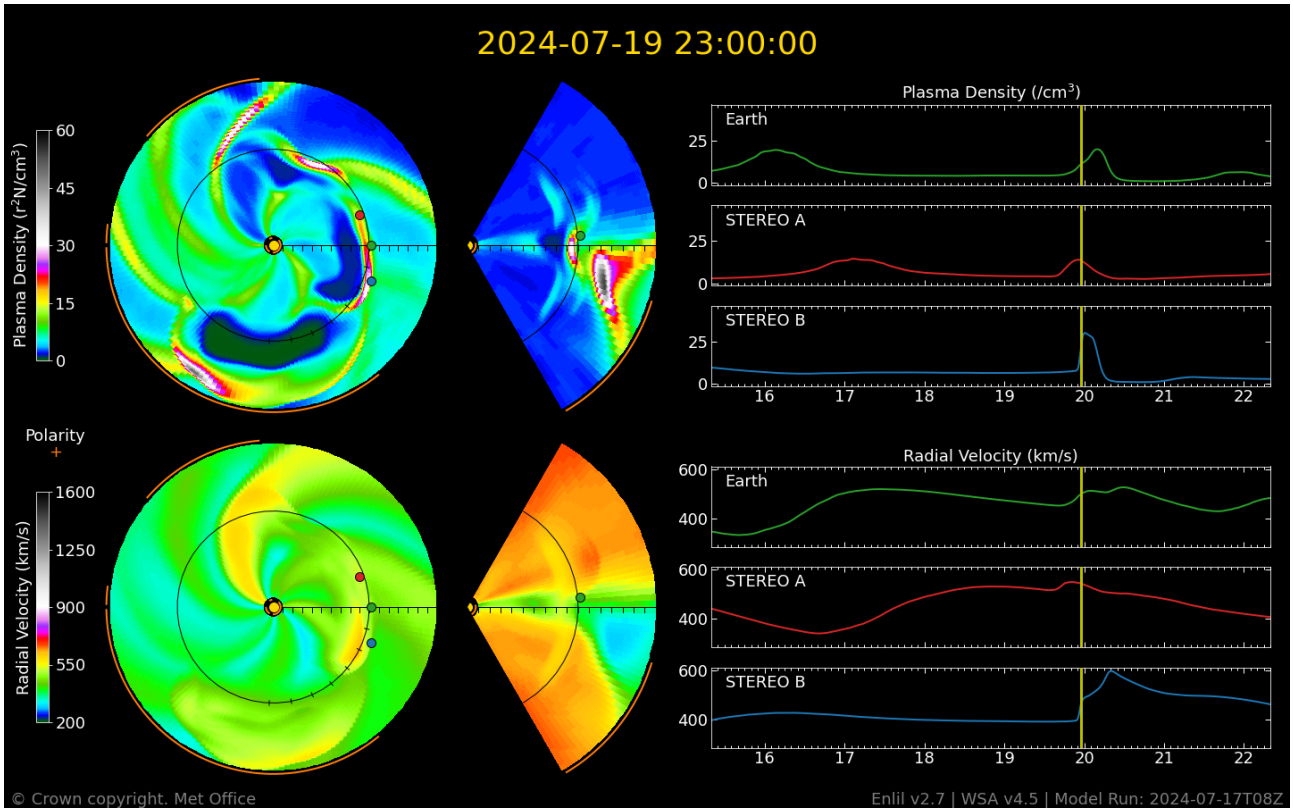
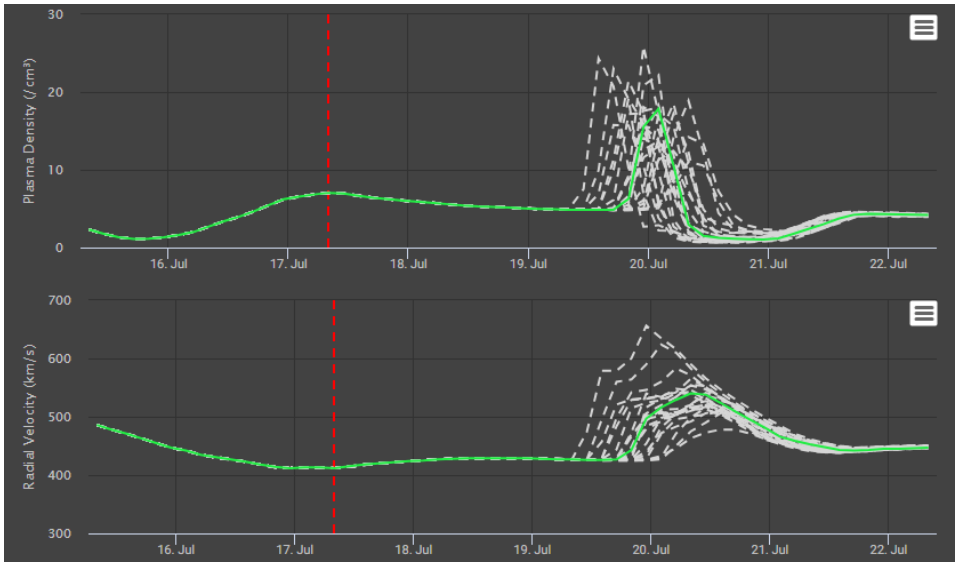
Figure 2: Enlil ensemble. Envelope likely biased too early due to over-estimation of influence of CH54/-





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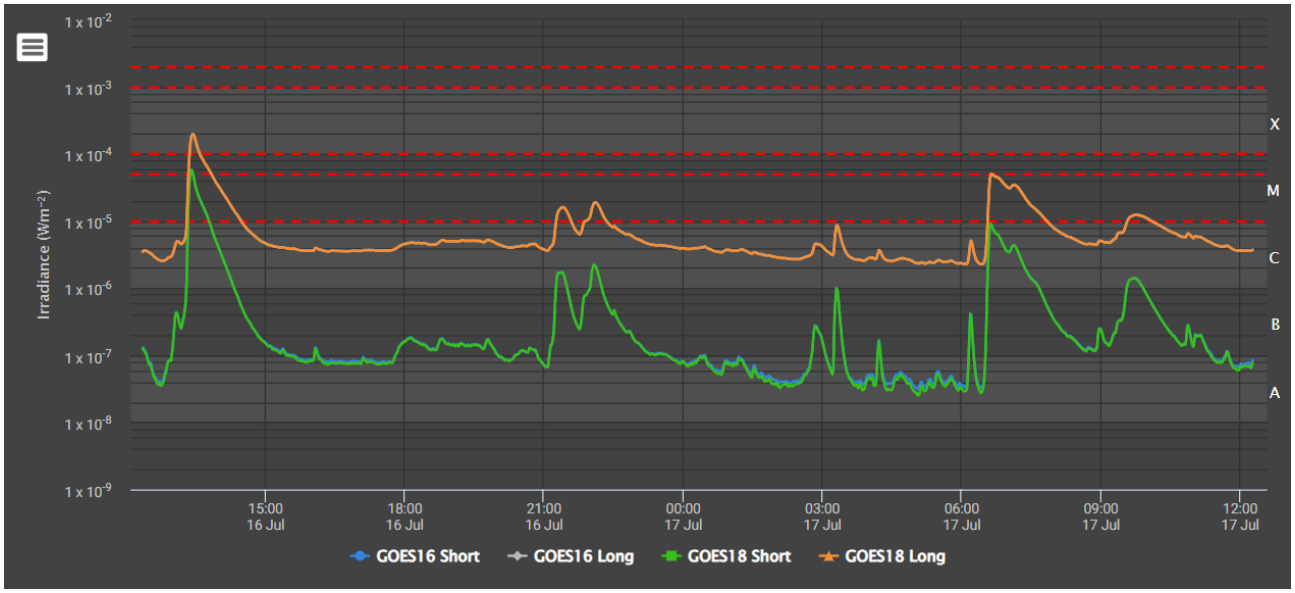
Radio Blackouts - X-Ray Flares:

Moderate with a chance of High activity is forecast at first, but likely becoming more generally Moderate from day 3 (19 Jul). This is due to an ongoing chance of X-flares from AR3738, which will only recede later on day 2, as the magnetic looping of the spot retreats further over the western limb. Further occasional M-flares are expected throughout.

There are currently nineteen sunspots on the disc, although these are generally relatively small with limited complexity. A significant flare risk continues from AR3738, which is now impossible to analyse, just over on the southwest limb. The most complex region on the disc is AR3751 in the southeast, with a moderately strong delta spot, and some ongoing flux emergence to its southeast that may further complexify the region, although growth has recently stalled. Aside from AR3738, the most active region is AR3743 in the southwest. While at first glance, a relatively small region, this recently produced an M5-flare and continues to show some ongoing slow development, along with a complex magnetic structure that connects to nearby AR3745 and AR3747 to its south. Other regions of note include AR3753 And AR3744 in the northwest, as a source of recent M1 flares, and the subsequent CME, along with AR3755 near the east limb which is showing some sign of growth.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	75	70	70
Very Active	R3 to R5 X Class	Yes	25	15	10	10

Figure 3: GOES-16/18 X-ray flux



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux at GOES18 is at background. There remains a slight chance of exceeding the S1/Minor radiation storm threshold should any significant flares occur from AR3738 while this remains in a good location at present for solar radiation events to connect with Earth, before receding further onto the far-side. However, recent X-class flares from this region have not produced any perceptible increases to the observed flux, decreasing confidence in this risk. A slight risk is maintained however due to the number of sunspot regions on the disc, including AR3743 and surrounding spots in the southwest, which produced an M5 flare on 17 Jul.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux as observed by GOES-16 is expected to remain at background. Any subsequent fast wind connection may lead to flux rising to give spells of Moderate day 2 (19 Jul), however any increase is likely to quickly be suppressed by the onset of any CME arrival.

The associated electron fluence is expected to persist below the Active level with MOSWOC REFM currently providing good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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